U.S. Fish & Wildlife Service

Yukon River Fall Chum Salmon Mixed-Stock Analysis

Meeting Management's Needs

Fishery Closure!

A state disaster was declared in July of 2000 when Yukon River chum salmon runs collapsed, highlighting the importance of this resource to subsistence users. Yukon River chum salmon are managed under Pacific Salmon Treaty (PST) mandates to conserve and equitably share the resource between the United States and Canada. To manage Yukon River chum salmon effectively and allocate catches equitably, harvest estimates for individual populations must be determined. This task is difficult because the harvest of these populations takes place before they segregate into spawning aggregates.

Having the ability to identify the origin of chum salmon in population mixtures (e.g., during migration and in harvests) would simplify management. One area of primary concern is the distinction between chum salmon originating in the United States and Canada. Mixed-stock analysis (MSA) has been used successfully to address similar issues in Alaska, British Columbia, and the Pacific Northwest. However, attempts to use MSA for Yukon River chum salmon using genetic marker types such as allozymes, microsatellites, and mitochondrial DNA have not revealed sufficient resolution to manage chum salmon populations adjacent to the U.S./Canada border by country of origin according to standards set by the PST Joint Technical Committee (PSTJTC).

The success of MSA largely depends on the amount of genetic divergence among the populations in question. The apparent lack of divergence detected among Yukon River chum salmon populations may be attributed to either limitations of previously used genetic techniques or a true reflection of their life history traits (i.e. relatively high straying rates among spawning populations).

Chum salmon in a tributary of the Yukon River.

Can a new technique improve MSA?

In the Conservation Genetics Laboratory we attempted to improve MSA resolution of the border populations. To do this, we applied amplified fragment length polymorphism (AFLP) analysis. Using non-lethal fin tissue samples, this technique surveys the entire genome, circumventing some of the limitations associated with the previous markers. Failure of AFLP analysis to improve MSA resolution would be a strong indication that results are limited by Yukon River chum salmon life history traits and not by marker type.

Life history dominates - but MSA was improved.

The AFLP, allozyme, and microsatellite data sets reveal the same population structure and are highly correlated ($R^2 = 0.78$, $P < 0.0001$). Nevertheless, AFLP analysis was successful in improving MSA estimates for border populations by country of origin. AFLP analysis provided:

- 6.5% improvement over microsatellites;
- 8.5% improvement over allozymes;
- estimates that met the PSTJTC requirements.

With this level of MSA resolution, U.S. and Canadian stocks can be estimated accurately. For example, AFLP analysis of a sample of 1000 chum salmon with 500 each from the U.S. and Canadian border

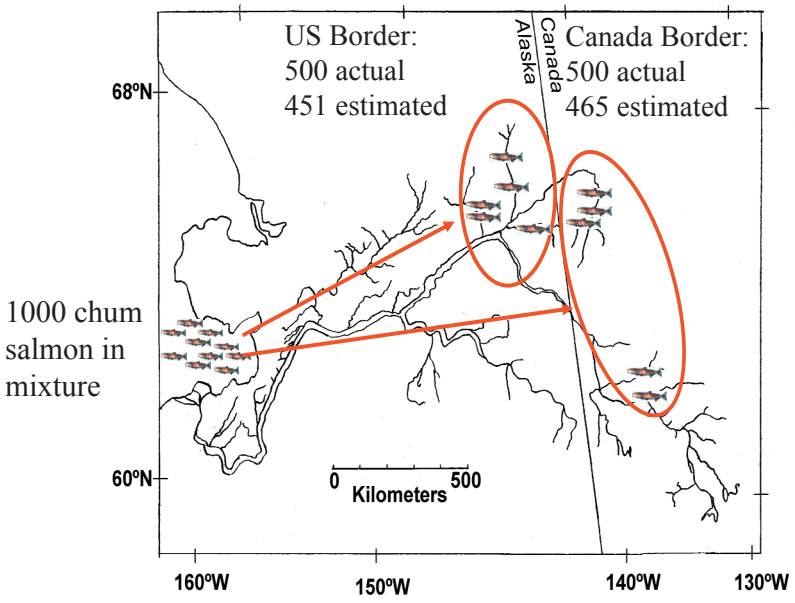
regions yields estimates of 451 ± 124 (± = 95% confidence interval) and 465 ± 115 chum salmon of U.S. and Canadian origins, respectively. Only 84 ± 61 of the 1000 chum salmon would be potentially misallocated through AFLP analysis.

MSA as a management tool for Yukon River chum salmon.

MSA offers managers a powerful tool for evaluating fisheries. Current management of Yukon River chum salmon relies on sonar and weir enumeration, test fishery catch per unit effort (CPUE), and subsistence harvest reports to assess run strength. The fact that fall chum salmon usually enter the river in four to five pulses associated with offshore wind events or high tides complicates this assessment. For example, in 2001 the first pulse of fall chum salmon was among the largest recorded at 109,000 fish. However, subsequent pulses were weak and the overall run was poor. Runs have been depressed since 1998 and subsistence and commercial fishing have been restricted or closed when the run size goes below 600,000 fish. If there is an indicator that a region will exceed escapement goals, a directed fishery may be opened. Unfortunately, inseason run assessment tools are generally inadequate to allow directed fisheries. However, region-specific pulses of chum salmon may be detectable by MSA, thus assisting managers in making inseason assessments and regulating fisheries.

AFLP analysis shows strong potential for estimating harvest proportions, run timing, and migratory patterns for stock groups (biological and political), as well as for real time management of mixed stock fisheries. Further simulations performed on realistic mixture scenarios and blind MSA tests on samples of known origin will help to fully evaluate the application of AFLP loci to MSA. Mixed-stock analysis is one of the best tools available and should be considered for integration into various management strategies for Yukon River chum salmon.

Fish wheels, used for subsistence fishing, are a common sight along the Yukon River.



Schematic of MSA resolution using AFLP analysis, demonstrating the potential country of origin estimates for border populations.

The Conservation Genetics Laboratory was established in Anchorage, Alaska in 1987 and currently maintains a team of 11 geneticists, biologists and technicians utilizing an Hitachi FM BIO II® and four LI-COR IR²® DNA analyzers.

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